Microstructure and Physical Properties

Capabilities/Facilities

Optical metallography, including sample preparation; environmental scanning electron microscopy; scanning transmission electron microscopy; X-ray diffraction with high temperature capability; thermal analysis; Auger and XPS surface analysis; scanning probe microscopies; nano-indentation mechanical property analysis; thermo-physical property characterization of radioactive materials; scanning electron microscope with energy and wave length-dispersive spectroscopy and electron backscatter detector; transmission electron microscope with energy dispersive X-ray spectroscopy, electron diffraction, high-resolution capability; sample handling for radioactive materials; orientation imaging microscopy; and X-ray diffraction with hot stage for radiological samples. Facilities for preparation of activated metallic and ceramic samples.

Materials

Wide range of engineering alloys and intermetallics; oxide, nitride and carbide ceramics; waste forms and coating materials; and metals, ceramics, sludges, and powders containing uranium, plutonium, corrosion products, and minor actinides.

Scientific/Engineering Issues

Microstructure/property relationships, fundamental and applied corrosion studies, high temperature phase stability, environmental effects, coating performance, and membrane characterization; determination of thermophysical properties of nuclear materials; irradiation effects; phase identification; micro structural and chemical characterization with high spatial resolution.

A laser flash thermal diffusivity system is used to characterize physical properties of multi-layer materials.

Staff

P.J. Pinhero, T.E. Lister, T. O'Holleran, J.-F. Jue, J.R. Kennedy, J. Gan, J.I. Cole, D.D. Keiser, D.E. Janney, S.M. Frank, M.J. Lambregts.

Recent Projects

- Fabrication and characterization of dual-phase MgO-based ceramics for use as an inert fuel matrix
- Temper embrittlement of ferritic ODS alloys
- Determination of thermophysical properties of Pu- and minor-actinide-bearing alloys for the Advanced Fuel Cycle Initiative
- Measurement of ignition temperature of hydride uranium
- Development of alloys with improved radiation resistance for DOE's Nuclear Energy Research Initiative
- Development of Gas Fast Reactor materials for DOE's Generation IV nuclear reactor
- Evaluation and development of materials for Generation IV supercritical water reactors for DOE's International Nuclear Energy Research Initiative
- Assessing long-term radiation effects in EBR-II structural hardware

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Science
INL
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INL is a U.S. Department of Energy national laboratory operated by Battelle Energy Alliance

- Characterization of actinide distributions in intermetallic materials in simulated metallic waste forms
- Characterization of corrosion products on simulated metallic waste forms

Collaborations

- University of Utah
- Lehigh University
- Sandia National Laboratory
- Supporting Texas A&M student on doctoral thesis
- Japan Nuclear Cycle Development Institute
- University of Michigan
- University of Wisconsin
- Korea-DOE Nuclear Energy Research Initiative

Publications

"Phase Relations in Neptunium Bearing Plutonium-Zirconium Alloys," J.R. Kennedy, J.R. Stuart, D.D. Keiser, S.M. Frank and M. Meyer, *Transaction American Nuclear Society*, Vol. 87, p. 357, 2002.

"Effect of Irradiation on Microstructure and Microchemistry of Grain Boundary Engineered Austenitic Alloys," J. Gan, J.I. Cole, T.R. Allen, R.B. Dropek, G.S. Was, and E.A. Kenik, to be published in *Philosophical Magazine*.

"Effect of Zr on the Irradiated Microstructure and Hardening in Type 304 Stainless Steel," J. Gan, J.I. Cole, T.R. Allen, R.B. Dropek and G.S. Was, *Fusion Science and Technology*, Vol. 44, p. 191, 2003.

"Microstructure and Post-Irradiation Annealing Behavior of 20% Cold-Worked 316 Stainless Steel," J.I. Cole, T.R. Allen, H. Kusanagi, K. Dohi, and J. Ohta, *Microstructure Processes in Irradiated Materials,* Materials Research Society Symposium Process, Vol. 650, Materials Research Society, 2001, R2.9.

"Microstructural Changes Induced by Post-Irradiation Annealing of Neutron-Irradiated Austenitic Stainless Steels," J.I. Cole and T.R. Allen, *Journal of Nuclear Materials,* 283-287 (2000) 329.

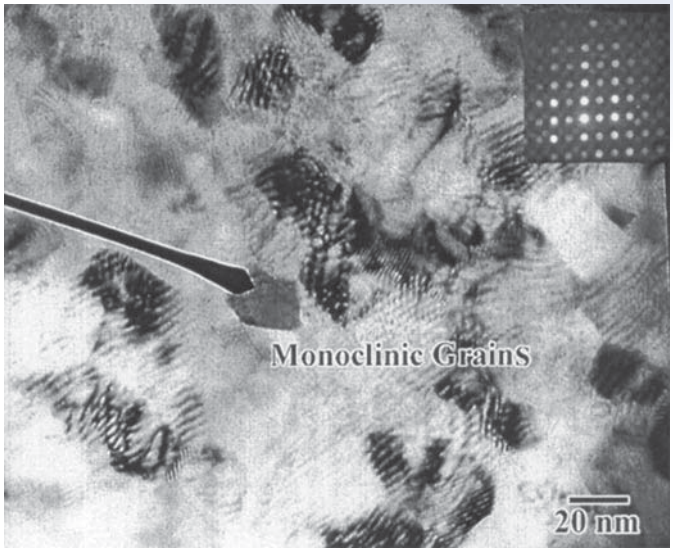
"The Effects of Long Time Irradiation and Thermal Aging on 304 Stainless Steel," T.R. Allen, J.I. Cole, C.L. Trybus and D.L. Porter, *Journal of Nuclear Materials,* 282 (2000) 171.

"Host phases for actinides in simulated metallic waste forms", D.E. Janney, Journal of Nuclear Materials, 323 (2003), 81-92.

"Actinides in metallic waste from electrometallurgical treatment of spent fuel", JOM_ 55 (9), (2003), 59-60.

"Thermal cycling of siliconized-SiC at high temperatures", P.A. Lessing, A.W. Erickson, and D.C. Kunerth, *Journal of Materials Science,* 36, p. 1389-1394, 2001.

"Synthesis and characterization of gadolinium phosphate neutron absorber", P.A. Lessing and A.W. Erickson, *Journal of the European Ceramic Society,* 23, p. 3049-2057, 2003.



Transmission electron microscope image of Zr oxide corrosion product formed on irradiated improved Zircaloy-4 cladding during exposure to high temperature water.